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The Journal of HEREDITY

A monthly publication devoted to Plant Breeding Animal Breeding and Eugenics

AUGUST, 1924

INHERITANCE OF CANCER
LEONELL C. STRONG

GIANT MAIZE FROM MEXICO
J. H. KEMPTON

HEREDITY OF FUSED FINGER BONES
R. A. HEFNER—O. L. INMAN

THE SEARCH FOR DEEPER KNOWLEDGE
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MOTTLING OF SOYBEANS
WOODWORTH AND COLE

RACE PREJUDICE
A REVIEW

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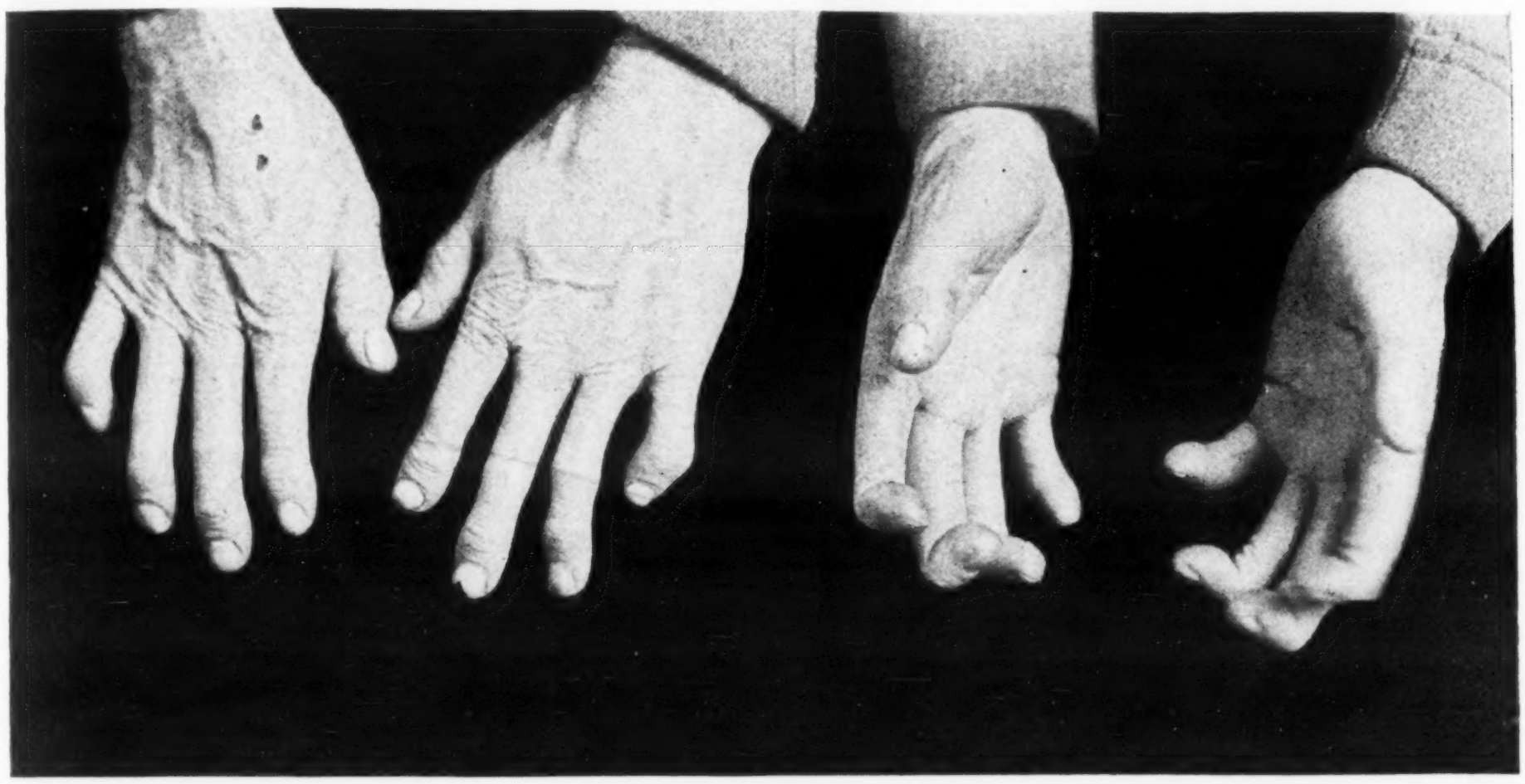
FUSED JOINTS IN ALL FOUR FINGERS

This relatively rare abnormality happens to be one that is known to have been inherited for a greater number of generations than any other skeletal defect, with the possible exception of the "Hapsburg jaw." John Talbot, first Earl of Shrewsbury, was supposed to have had fingers with stiff joints. He was killed in battle near Bordeaux in 1453, by a blow on the head, received after his thigh had been broken. He was buried in Shrewsbury Cathedral. Recent alterations made it necessary to disturb his grave, when tradition was confirmed and his bones identified by the fused finger-joints, the cleft skull, and the broken thigh-bone. By a strange coincidence this work was under the direction of one of Talbot's direct descendants in the fourteenth generation, the joints of whose fingers were fused like those of his remote ancestor, much as are these in the hands shown in Figure 1. (Frontispiece)

INHERITED ABNORMALITIES OF THE FINGERS

I. Symphalangism*

R. A. HEFNER
Ohio State University



ALL OF THE FINGERS WITH FUSED PHALANGEAL JOINTS

FIGURE 1. These are the hands of a man about fifty years old. Note the column-like fingers and the peculiar flexure of the movable joints. Individuals having only one or two fingers with fused joints can flex all their fingers in this way, which is almost impossible for the normal hand. Possibly muscular abnormality precedes the fusion of the joints in these cases. An x-ray photograph of the right hand of this individual is shown on the opposite page.

THE human race is characterized by the abundance of its morphological variations. Less apparent than their universal occurrence is the fact that such variations are often unit characters which are transmitted in a definite manner through the operation of the familar laws of Mendelian heredity. Farabee[4]† and Drinkwater[3] each presenting studies of brachydactylism, were pioneers in emphasizing the Mendelian behavior of human hereditary traits. Various workers in the fields of genetics and medicine have presented monographs on other digital variations, prominent among these being syndactylism and polydactylism.

It is the purpose of this paper to present a variation apparently less abundant than any of the above mentioned traits but previously described by Walker[7] and Cushing[2]‡ and by the latter given the designation—*Symphalangism.*

*Presented before the Ohio Academy of Science, April 19, 1924.
†For numbered references see *Literature Cited* at end of article.
‡Popenoe and Johnson *(Applied Eugenics, 1920)* mention a family located by F. N. Duncan and related to that described by Cushing.

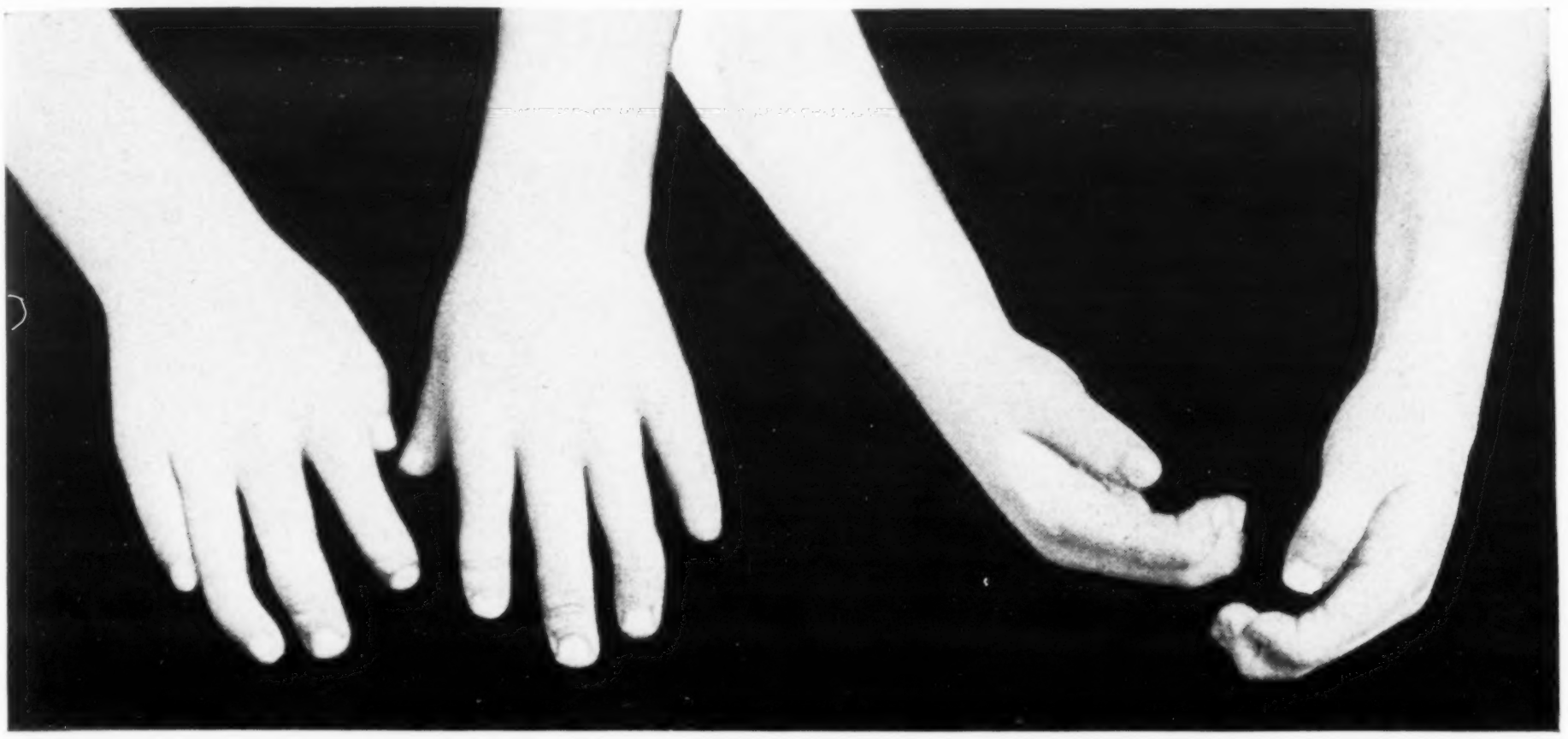
"DOUBLE SYMPHALANGISM" OF THE RING FINGER

FIGURE 2. Note that the ring finger of the right hand has both phalangeal joints fused, making it inflexible beyond the metacarpal joint. These are the hands of the nine-year-old girl, shown on the opposite page. Ossification of the bones of the hand is not complete at this age, as can be clearly seen by a comparison with the preceding x-ray picture.

Description

Symphalangism is characterized by an anchylosis or fusion of the first and second phalanges of some or all of the fingers of both hands. To all external appearances there is, in the adult, no indication of a joint—the skin being so smooth as to give a column-like appearance to the finger between metacarpal and terminal joints. The presence of the fused joint is clearly revealed by the x-ray photograph.

The trait is present from birth and undergoes only slight modifications as a result of the occupational requirements of the affected individual. Of the persons studied, practically all were accustomed to manual labor and seemed to suffer little inconvenience by reason of their unusual inheritance. At least one farm wife had adapted herself to accomplish the task of milking, in spite of her inability to close the hand completely. The writer was surprised to observe that the peculiar flexure of the terminal joints (Figure 1) could be accurately imitated in all fingers by an individual in whom the little fingers alone were affected—a feat which the normal hand could hardly accomplish. This observation would suggest a muscular adjustment to the peculiar conditions of the defective hand, or at least present a question as to the priority of the two conditions. As a matter of speculation, it seems probable the abnormality may have been originally imposed by the absence of a functional sub-



HANDS OF A NINE-YEAR-OLD GIRL

FIGURE 3. Two positions of the hands are shown, to bring out the peculiar way of flexing the fingers. Inability to close the hand entirely might be expected to interfere seriously with manual dexterity, but as a matter of fact the fused joints appear to cause little inconvenience.

limus muscle since all fingers are apparently flexed by the profundus, regardless of the degree of fusion manifested.

When fused at the proximal joint, the medial phalanx is often further modified by being considerably shortened, especially in the little finger (Figure 4). An exceptionally flat foot is usually, if not always, associated with symphlangism. These associations have been previously mentioned in the papers of both Walker and Cushing.

Variations

From a summary of the accompanying chart the following facts pertaining to variations in the numbers of fused digits may be observed:

14	persons	show	4	fingers	of	each	hand	affected.
2	"	"	2	"	"	"	"	"
5	"	"	1	"	"	"	"	"

In addition to this, Cushing (the relation will be mentioned later) describes individuals in which three fingers of each hand are affected, thus completing the series.

It is remarkable to note that in every instance where less than four fingers are affected, the fusion occurs in the fingers away from the index. Thus, when three fingers are affected, the index alone is capable of complete flexure; when two fingers are affected, the index and middle fingers are flexible; when but one finger is affected, all except the little finger are apparently normal, this last digit alone showing a fused joint.

The fact that the medial phalanges are the last to ossify in the embryo might indicate the absence of a normal inhibiting influence as the cause of the excessive ossification, here resulting in fusion of the proximal joints. The greater frequency of fusion in the little finger may be suggestively correlated with the relatively late period of ossification in the first and second phalanges if this digit, but the same

FUSED JOINTS IN FINGERS OF THREE-YEAR-OLD CHILD

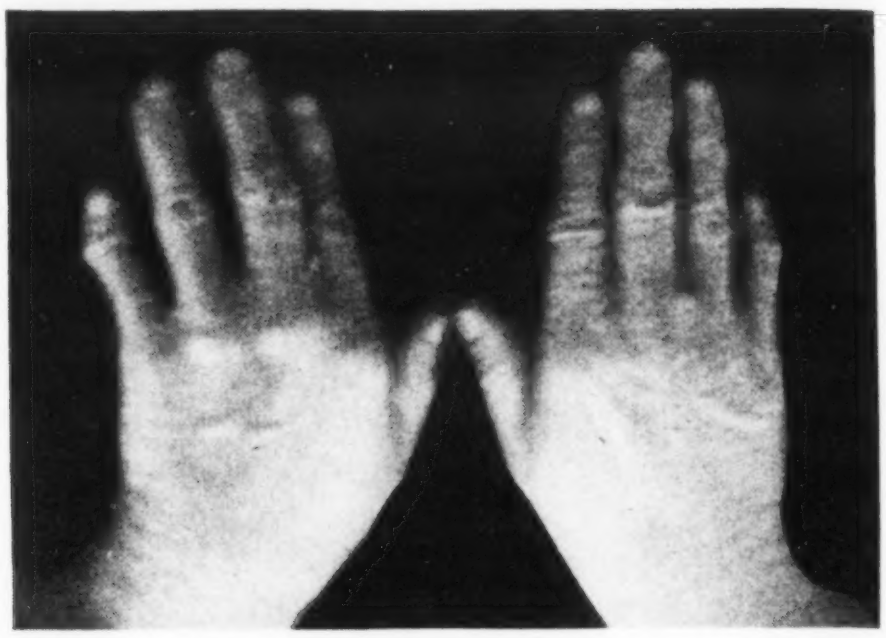
FIGURE 4. Fusion of the phalangeal joints of all four fingers is evident. The shortened medial phalanges, especially of the little finger, are distinctive of symphalangism. Note the prominent growth regions as larger openings between the bones.

assumption cannot be serially applied to the frequency of fusion in the remaining digits.

Individual 3 of family 2 in the sixth generation presents a variation in that, not only are the first and second phalanges of all fingers united, but the second and third phalanges of the ring finger of the right hand are also fused, making the finger one inflexible continuation from the metacarpal joint (Figure 2).

Walker describes a marked variation in the entire absence of the second and third phalanges of the ring finger and the little finger of the right hand. This variation, occurring in two individuals of one family, is apparently without assignable cause.

The case of individual 3 of family 2 in the third generation presents

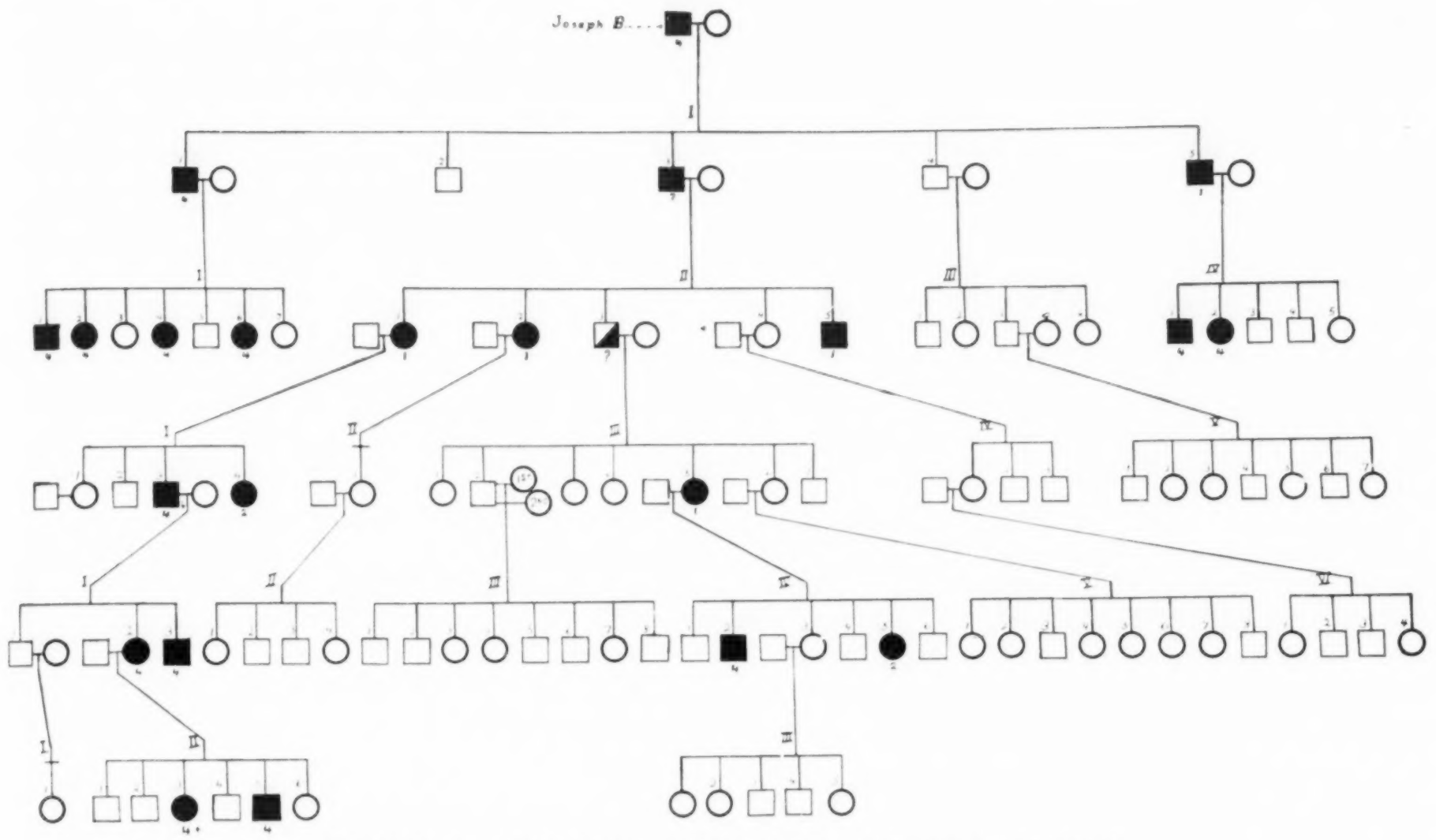


SYMPHALANGISM IN LITTLE FINGER ONLY

FIGURE 5. Only the joints of the little fingers are affected, as can be seen by the characteristic crookedness of these fingers, but variations in the degrees of symphalangism are not transmitted. Of this woman's six chidren, four were normal, and two showed the defect in its fullest extent, with all four fingers affected.

a difficult problem. This person (now deceased), is reported as having been normal by three of his living relatives. One of these informants states that the fingers became crooked with age and another (the wife of the subject in question) adds that he had the flat feet characteristic of the affected members of the family. The fact that the unaffected sister is also flatfooted bars this observation as conclusive evidence of the defective character. Married to a normal woman, this person leaves seven children, six of whom are normal and show no evidence of transmitting the defect. One daughter, however, shows symphalangism in its least observable condition—fusion in the little fingers only (Figure 5). Of her six children, two show the defect in its fullest extent, all the fingers of each hand bearing one fused joint.

It is of interest to note that Cushing observed a similar case in his investigation. An x-ray photograph of the hands of the subject revealed an abnormal median phalanx of the little finger. It would thus appear that the least degree in which the character may exist is so modified that no



SYMPHALANGISM FOR SIX GENERATIONS

FIGURE 6. Like other skeletal defects, symphalangism is inherited as a Mendelian dominant character. The fused joints are passed on by affected individuals to half their offspring, which is to be expected in the mating of a heterozygous dominant and a pure recessive. This family is believed to be related to other families in which symphalangism has been studied previously, so that all may trace back to an original ancestor.

fusion of the phalanges occurs and detection is, in such an instance, exceedingly difficult.

From the review of these cases and a general summary of the line of inheritance as shown by the accompanying chart, the writer is inclined to agree with Cushing's conclusion wherein he states, "It is probable that the trait may be transmitted in its most outspoken form by a parent who appears to be but slightly affected, but never through parents both of whom are unaffected."

Historical

The earliest record of the trait, as obtained by the present informant, dates back to about the period marking the close of the American Revolution, at which time the person designated as Joseph B. emigrated with his wife from Virginia to Ohio. Accompanying the couple or born in the latter state were five sons, two of whom were normal and two who had complete symphalangism of the proximal joints of both hands. The hands of the fifth son were reported as defective, but the extent of the fusion could not be determined due to the fact that he was killed in a boiler explosion at a time beyond memory of any living member of the family. This lack of information is regrettable on account of the unusual problem presented by his descendants, listed as family 2 of generation 3 in the chart.

Of the descendants of these five sons, one of the normals remained unmarried and the children of the others have little interest in this paper other than to emphasize the non-transmission of the trait through normal individuals. Of the two members known to possess the trait, one moved as a young man to eastern Ohio and the whereabouts of the descendants of the other could not be ascertained. The one person in whom the extent of the character is questionable is thus the ancestor of all persons interviewed in this study.

With the possible exception pre-

viously mentioned, the trait has passed from parent to child in unbroken succession irrespective of sex. All living members here indicated reside in northwestern Ohio. The mental status of the group is at least equal to that which might be expected from a similar survey of any middle-class family and the physical stature is above average—some of the men being well over six feet in height and well proportioned.

An effort to associate this family with those previously described by Walker and Cushing has met with a fair degree of success. Dr. Walker is unable to supply any evidence that might indicate a relationship other than a statement to the effect that the family described in his paper also emigrated from Virginia. A relationship to the family described by Dr. Cushing is indicated by the fact that the original family name is the same in both cases and the ancestors of the Ohio group emigrated from that portion of Virginia where the families described in the earlier paper are located. Dr. Cushing expresses the opinion that the Joseph B. of this paper is a grandson of his William B. through a son, Low B., not mentioned in his (Cushing's) paper of 1916. This evident relationship offers confirmation of the extremely rare occurrence of this specific mutation in the human race.

Mendelism

Of ten families in which one parent possesses the trait, twenty-two children have fused joints and twenty-seven have normal hands. This ratio is somewhat disturbed by family 3 of the fourth generation, where but one child in seven shows the trait. Barring this family we would have an exact 1:1 ratio—an observation which leads to the conclusion that the factor is a distinct Mendelian dominant, since all matings are with normals and all affected individuals are heterozygous with respect to symphalangism. These mated to individuals bearing homozygous recessive factors for normal hands would yield the 1:1 ratio, according to Mendelian expectations. This conclusion confirms the results of Dr. Cushing's observations covering some thirty families.

The widely expounded idea of the localization of specified factors in definite genes must in this instance be modified or extended for application to the observed behavior of the character here presented. Such a factor must itself be capable of modification to produce the various aspects of the trait, since symphalangism presents a series of variations and even a disturbance of the characteristic bilateral symmetry. It is thus a logical deduction to assume that the gene itself is an organization subject to changes which are here expressed as a variable trait. The nature of such changes and the reasons for their occurrence must be intimately associated with the primary cause of the mutation itself.

Summary

1. Symphalangism is defined as congenital anchylosis or fusion of the proximal phalangeal joints of some or all the fingers of both hands.

2. The trait is inherited as a Mendelian dominant.

3. There is an apparent muscular inheritance or coordination adjusted to the condition of the defective hand.

4. The trait shows many variations, but such are not transmitted—i.e., any degree of symphalangism may appear in the offspring regardless of the degree manifested by the parent.

5. It is probable that the trait may be so modified that no external evidence of symphalangism can be detected.

6. The trait has been traced from parent to child through six generations.

7. There is evidence of a relationship between this family and those previously described—hence the mutation must be of rare occurence.

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FOUR GENERATIONS OF SYMPHALANGISM

O. L. Inman

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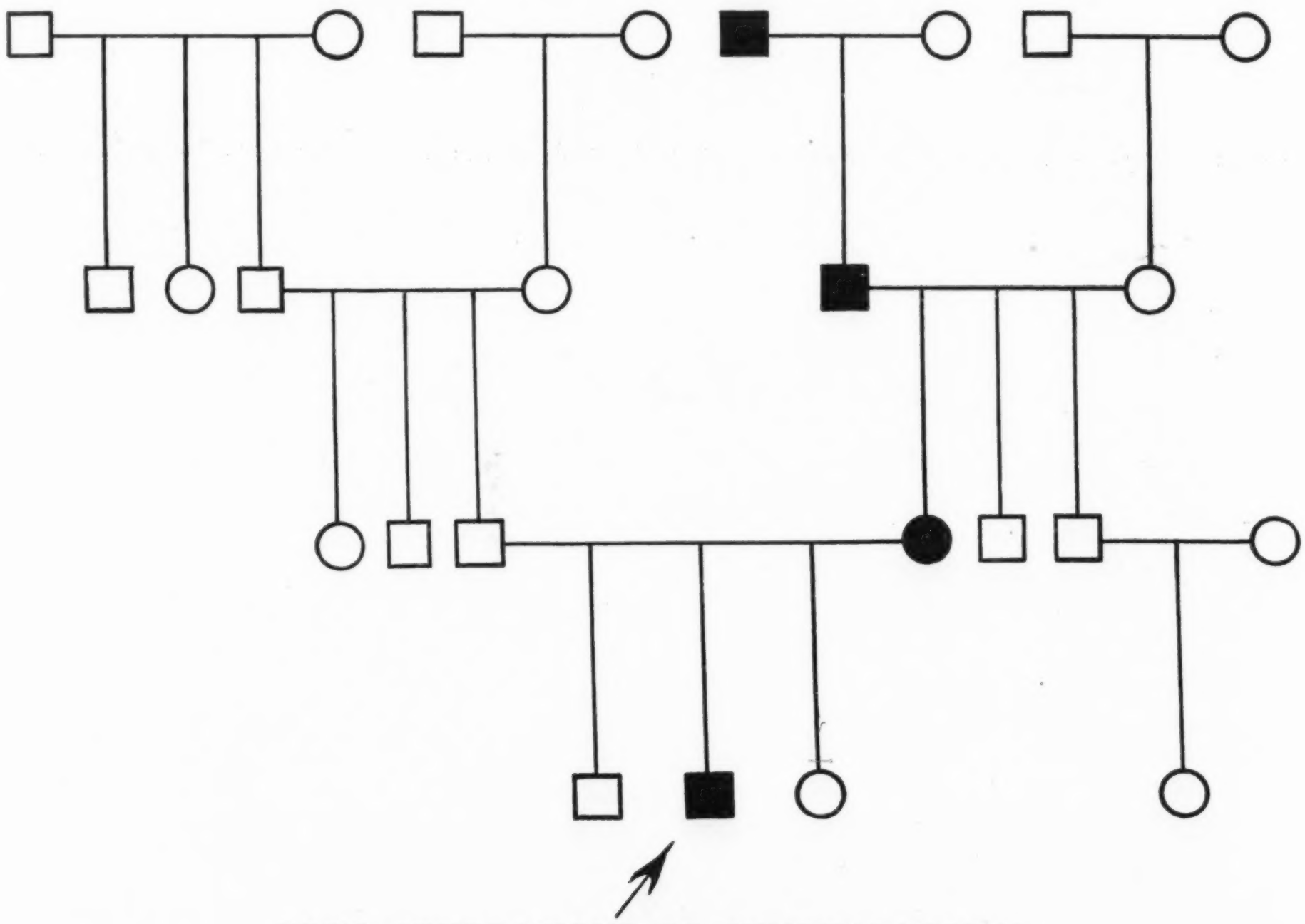


FOUR GENERATIONS OF SYMPHALANGISM

Figure 7. Another type of symphalangism traced through four generations. The small number of cases makes conclusions difficult regarding the mode of inheritance, but a Mendelian dominant character is indicated.

SYMPHALANGISM refers to the fusion of the joints of the fingers and toes and is generally considered closely related to brachydactyly, because with joint fusion there is often a shortening of the digits of the hands and feet. The primary defects of brachydactyly are usually found in the hands with secondary defects in other portions of the skeleton. Such

TWO FINGERS WITH FUSED JOINTS

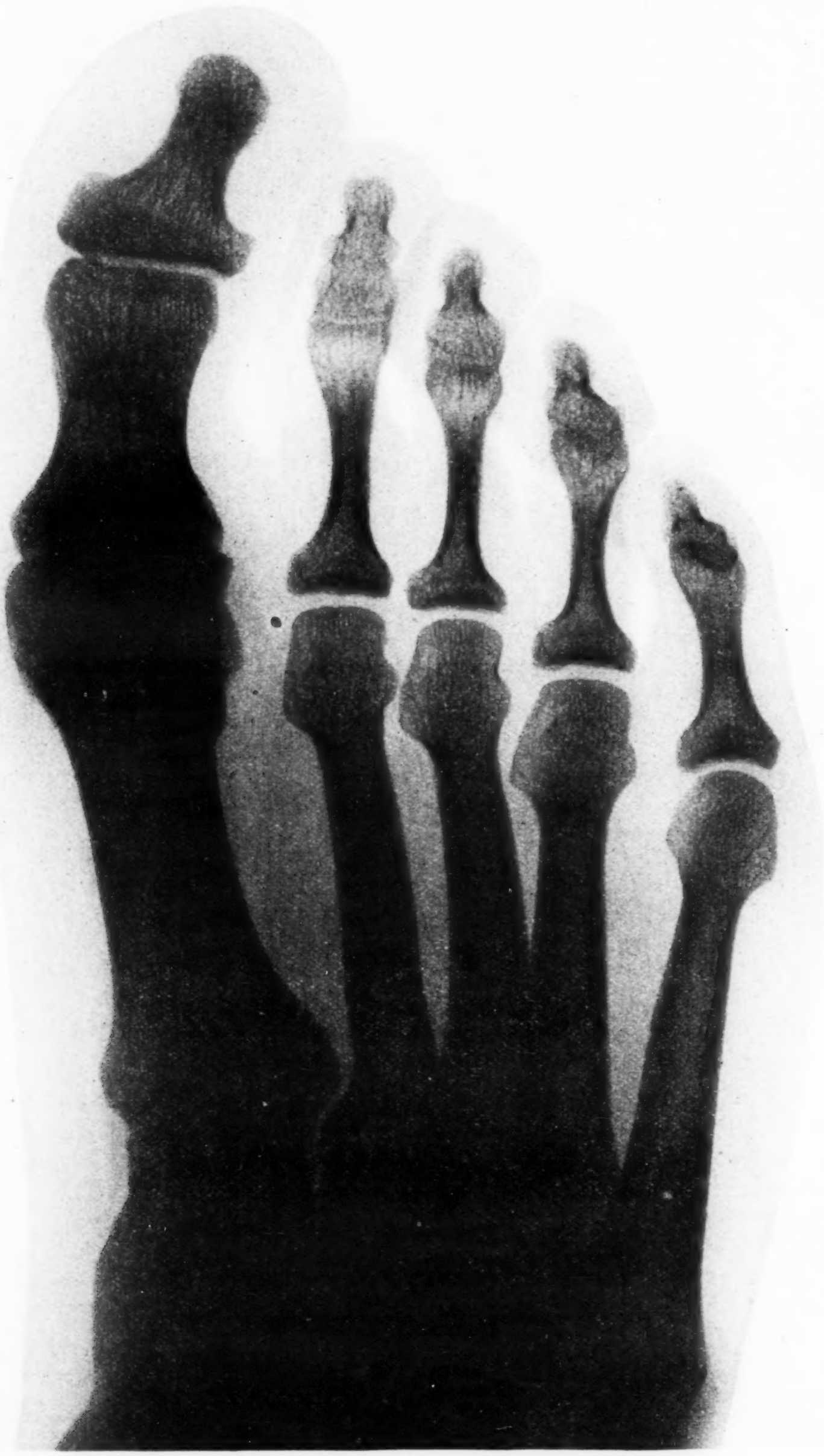
FIGURE 8. In the type of symphalangism described in the preceding article, the joint in the index finger was never fused unless all the other fingers were affected, while in this family only the index finger and the little finger have fused joints, the others being normal.

RIGHT HAND OF AFFECTED INDIVIDUAL

FIGURE 9. Some digital abnormalities are frequently unequal in the two hands, but in the present case the remarkable symmetry of the hands is a further evidence of a distinct type of variation.

LEFT FOOT OF AFFECTED INDIVIDUAL

FIGURE 10. Both phalangeal joints of four toes are fused, while in the "B————" family extreme flatfootedness accompanied symphalangism of the fingers, but fusion of the joints of the toes was not recorded.



RIGHT FOOT SHOWING FUSED PHALANGES OF TOES

FIGURE 11. Symphalangism of the hands would appear to be a much more serious handicap than having the bones of the toes fused, but the accompanying muscular weakness may cause flat feet.

skeletal defects as brachydactyly are generally known to behave as unit characters and to show dominance over the normal condition.

In this case of symphalangism there is very little if any shortening of the digits accompanying the fusion of the distal joints of some of the phalanges of hands and feet. Another feature is the fact that but two fingers on each hand are affected while on each foot four toes show fusion of the joints.

Figure 7 is a chart which shows that this abnormality does not appear in all the offspring of matings of abnormal with normal, and that there seems to be no indication of any sex-linkage throughout the four generations.

Figures 8-11 show x-ray photographs of the hands and feet of the boy who came under observation, indicated by the arrow in the chart.

Whether such modifications of the human skeleton as this case shows are a very great handicap to the individual in ordinary occupations I am unable to say, but certainly there is most likely to be some muscle deterioration accompanying joint fusion and thus a loss in ability to use the hands on special kinds of work, due to both muscle weakness and fused joints.

Some authors in speaking of symphalangism state that such sporadic occurrences as this have no evolutionary significance and are the mere playthings of scientists. Of this I am not so positive in my belief, since mutations, if one chooses to call these such, must be taken into account when they persist in a family for several generations. If observations on this type of skeletal abnormality do nothing else but show further than has already been done that there are physical abnormalities which are family traits, it may serve to stimulate further research on the inheritance of abnormal or normal mental traits. There are those in our society who argue lustily against the possibility of transmission of potential mentality and even some who doubt the transmission of physical defects and it may not be amiss to present all evidence at hand.

More Boys Than Girls

It is generally known that more boys are born than girls, and that in some families there seems to be a strong tendency to the production of one sex rather than the other. These and related facts have been studied for years. One of the latest contributions is that of Rainier Fetscher in the *Archiv f. Rassen-u. Gesellschaftsbiologie* (XV, No. 3). Dr. Fetscher draws three conclusions from the data he presents:

1. There is a tendency to production of an excess of boys, and this tendency is probably hereditary. (This is well supported by experimental studies of other animals, for instance, the work of Helen Dean King with rats.)

2. The influence of this tendency is perhaps associated with the age of the mother. With increased age of the mother there seems to be a tendency to production of a greater proportion of boys.

3. The age of the father apparently exercises no influence. P. P.

THE SEARCH FOR DEEPER KNOWLEDGE CANNOT WAIT

MARIAN H. BELL FAIRCHILD

IN THESE days of constant demands for money for hospitals and colleges and the suffering children of Europe, it is very easy to lose one's sense of proportion and feel that, with so many obviously necessary things crying to be done, it is better to let the things of doubtful practical value wait for less critical times.

But the search for deeper knowledge cannot wait; we must have an understanding of fundamental laws in order to make our foundations secure. We might succeed in building a skyscraper without knowing any mathematics, but the chances are that the building would very soon tumble down on our heads. Our hospitals were of comparatively little value in the days before germs and their carriers were known, in fact, they were breeding places of disease. Hundreds of thousands of women became infected in the hospitals and died of puerperal fever before it was known to be a germ disease. Thousands of men died of yellow fever, infected by mosquitoes that bred in the water in the saucers of the potted plants that were kept to brighten the wards. The increasing usefulness of our hospitals is in direct proportion to the number of discoveries that are being made in research laboratories by the men and women who are working with seaweeds and tadpoles and fish, rats and guinea pigs and rabbits.

Sometimes the most spectacular medical discoveries result from the work of a man who had no idea that the piece of "pure" scientific research he was carrying on would ever have any practical value. He was only indulging his insatiable curiosity for knowledge. An illustration of this is Dr. Dean's use in the cure of leprosy of the ethyl esters of chaulmoogra oil which Dr. Powers discovered.

In the same way, the agriculture of whole sections of our country, upon which the livelihood of many thousands of people depends, may be entirely changed by experiments in an attic laboratory, or by the work of a single man in his own back garden. The miles and miles of Marquis wheat fields that one travels through when going West on the Canadian Pacific all owe their existence to a single head of cold and drought-resisting wheat that Dr. Saunders, of Ottawa, discovered after years of patient, persistent work among hundreds of hybrids which he had made.

To have helped make possible such thousands of prosperous homes is surely a very constructive piece of philanthropy, and there are many other territories as great which are only waiting for some new plant or animal to be introduced or produced to make them fit living places for the right type of Americans.

The question of limiting immigration into this country is one of tremendously far-reaching importance. It may affect the whole industrial and social future of the United States, and it does affect the immediate lives of millions of people in every part of the world, and here we are blundering along, making laws about it, when we really know next to nothing about the problem as a whole. We know something about plant hybrids, and a little about the value of a thoroughbred racing horse or a milch cow. We are inclined to think that the result of the mixture of Spanish and Indian blood is bad while that of Hawaiian and Chinese is good, but that is about as far as our knowledge goes. And yet, is there any subject in the world of greater importance than the building of a better race? Are not most of our problems

now the problems of regulating and caring for the weakest part of our citizenry, the criminals, the ignorant, the destitute? If the whole level of the race were raised, how many of these problems would simply drop out of sight?

Many people will perhaps be inclined to say: "That is all very true, but how does the JOURNAL OF HEREDITY help all this?", and if they do say this, it is because they do not realize the big handicaps under which the research men and women do their work.

The big obvious difficulty of getting adequate financial support, of course, comes first, but running that a very close second is the difficulty of getting the results of their work before the public in their own way. They do not want to be dependent upon some newspaper or magazine writer to present their results in a more or less garbled form.

The JOURNAL OF HEREDITY publishes their original papers and photographs, thus affording the research workers the satisfaction and inspiration of knowing that they are giving a correct account of their discoveries to an intelligent and worth-while audience, an audience of about four thousand people, comprising many of the leaders in intellectual thought, in social reform, and in the study of economic questions. That this audience is able to get at first hand, facts and discoveries which will profoundly influence the future of the race is a matter of the utmost importance.

That the JOURNAL is destined to become of greater and greater value seems certain. The membership of the American Genetic Association is steadily increasing, and an additional income should soon be derived from advertising, so that the prospects for the future of the JOURNAL look better than ever before. At the present time, however, the costs of publication still exceed the income, and in the past this deficit has always been met by contributions from interested members, and in 1922, by a grant of $3,000 from the National Geographic Society. To insure adequate funds for the present year, one of the members of this Association has offered to contribute $100, provided 25 other members contribute a like amount, or if $2,500 is raised through smaller contributions. It is hoped that those who appreciate the importance of continuing the publication of the JOURNAL will lend their aid as their means allow, and make it possible to accept this offer.

Back Numbers of the Journal of Heredity Wanted

Numbers listed below should be mailed to the office of the Association, Victor Building, 724 Ninth St. N. W., Washington, D. C., and will be paid for at the prices indicated. Unless payment in cash is requested, members' accounts will be credited with the amounts due for the Journals received from them.

Vol. XIII, No. 7, 30c.
Vol. XI, Nos. 2 and 4, 30c.
Vol. V, Nos. 1, 4 and 7, 50c.
American Breeders Magazine, Vol. 3, No. 4, 80c.

JALA MAIZE

A Giant Variety from Mexico

J. H. KEMPTON
Bureau of Plant Industry

A FIELD OF JALA MAIZE

FIGURE 12. Situated near the town of Jala, Nayarit, Mexico. The plants in this field are twenty feet or more in height and the average length of the ears is about twenty inches. This field is a single block of approximately 640 acres, but it is managed as a community affair, comprising many small holdings. The town of Jala is seen in the background to the right, at the foot of the hill.

THE *Journal of Heredity* has served as the medium of publication for the largest trees in the continental United States and it seems appropriate that it should record also the largest type of corn known. Extremely large corn plants often make their appearance at the various Fairs throughout the agricultural states but these plants usually are the product of unusually favorable conditions and do not differ in their hereditary constitution from their normal but less favorably situated sisters.

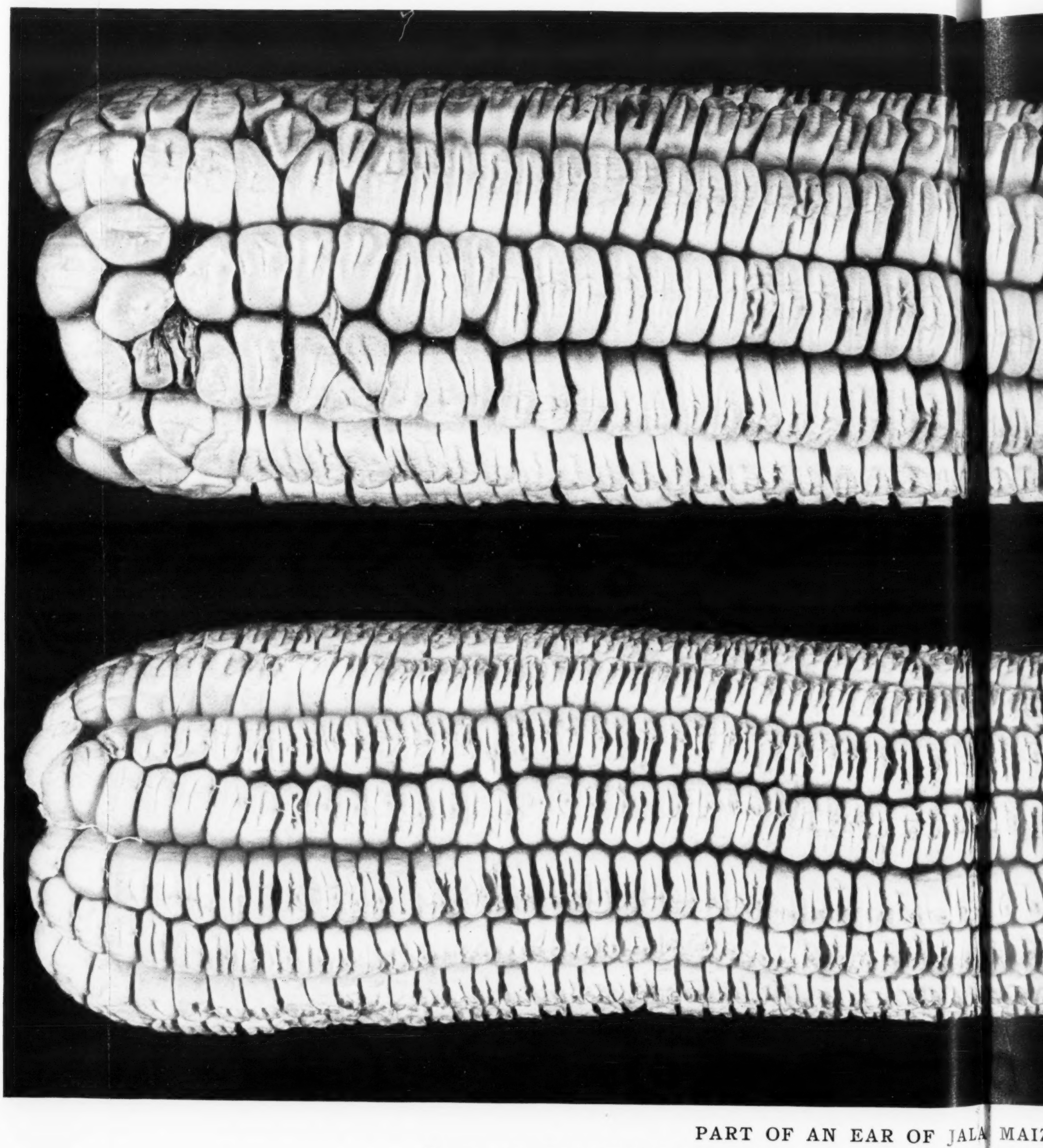
Throughout Central America and Mexico the agricultural explorer is constantly tantalized with accounts of a variety of maize having ears that roughly approximate three feet in length with a proportional diameter. Usually the locality given for this gigantic maize is just over the next mountain range or possibly just across the boundary of a bordering country. For several years past it has been one of our minor activities to inscribe ever narrowing circles around these localities, accompanied not unexpectedly with gradually diminishing dimensions of the ears. These concentric circles finally centered in the vicinity of Tepic

SKYSCRAPER CORN

FIGURE 13. A field of Jala maize, showing plants from which the leaves and tops have been removed for fodder. This photograph was made in October and while the ears were fully grown they were still far from mature. The corn is planted in April and is not ready to be harvested until November.

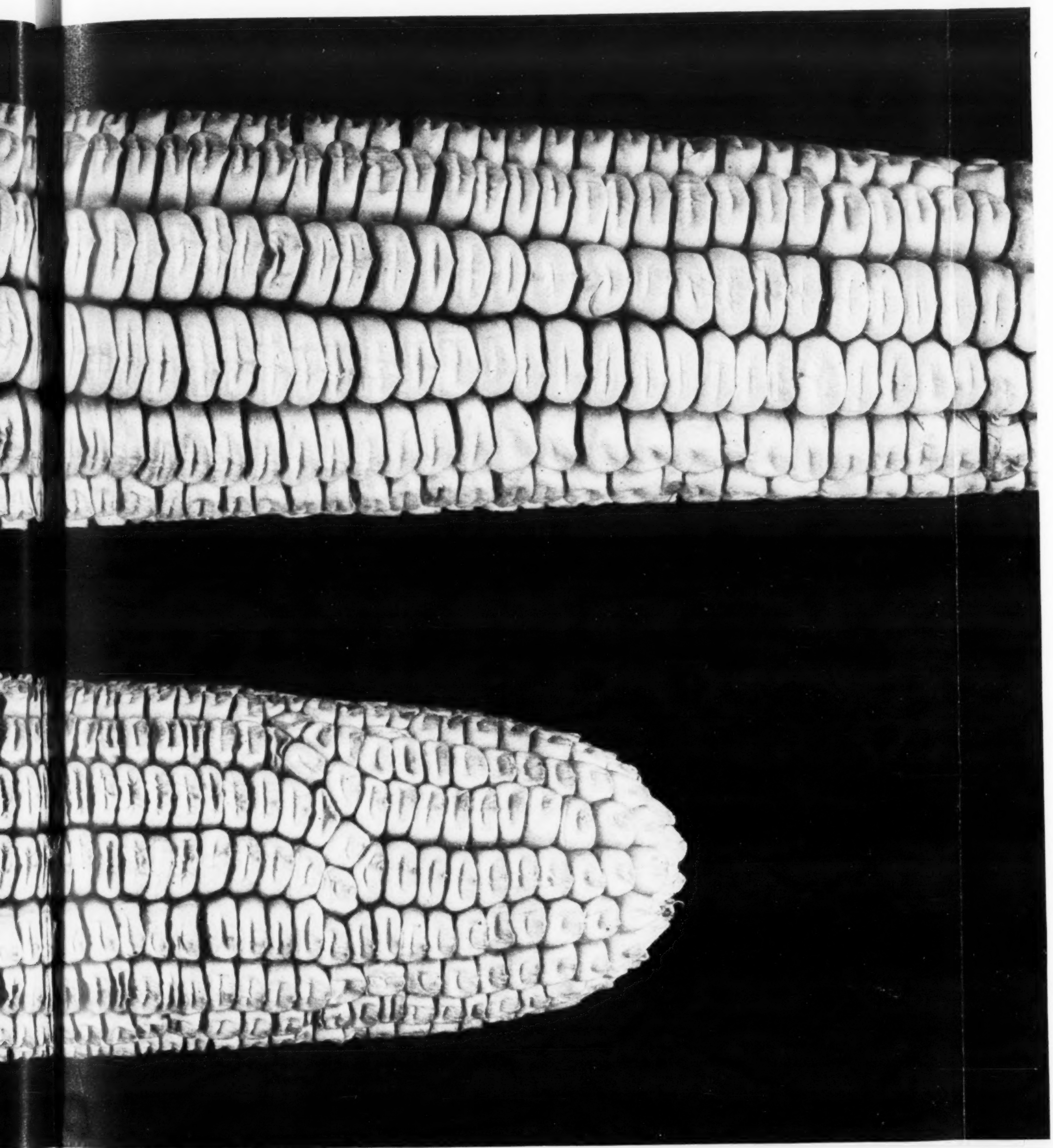
JALA MAIZE IN MARYLAND

FIGURE 14. The season at Lanham, Maryland, was far too short to mature a crop, but in unusually favorable years the plants reached a height of twenty feet and flowered before frost. The gigantic size of this variety is evidently inherent, and is not due to unusually favorable conditions for growth.



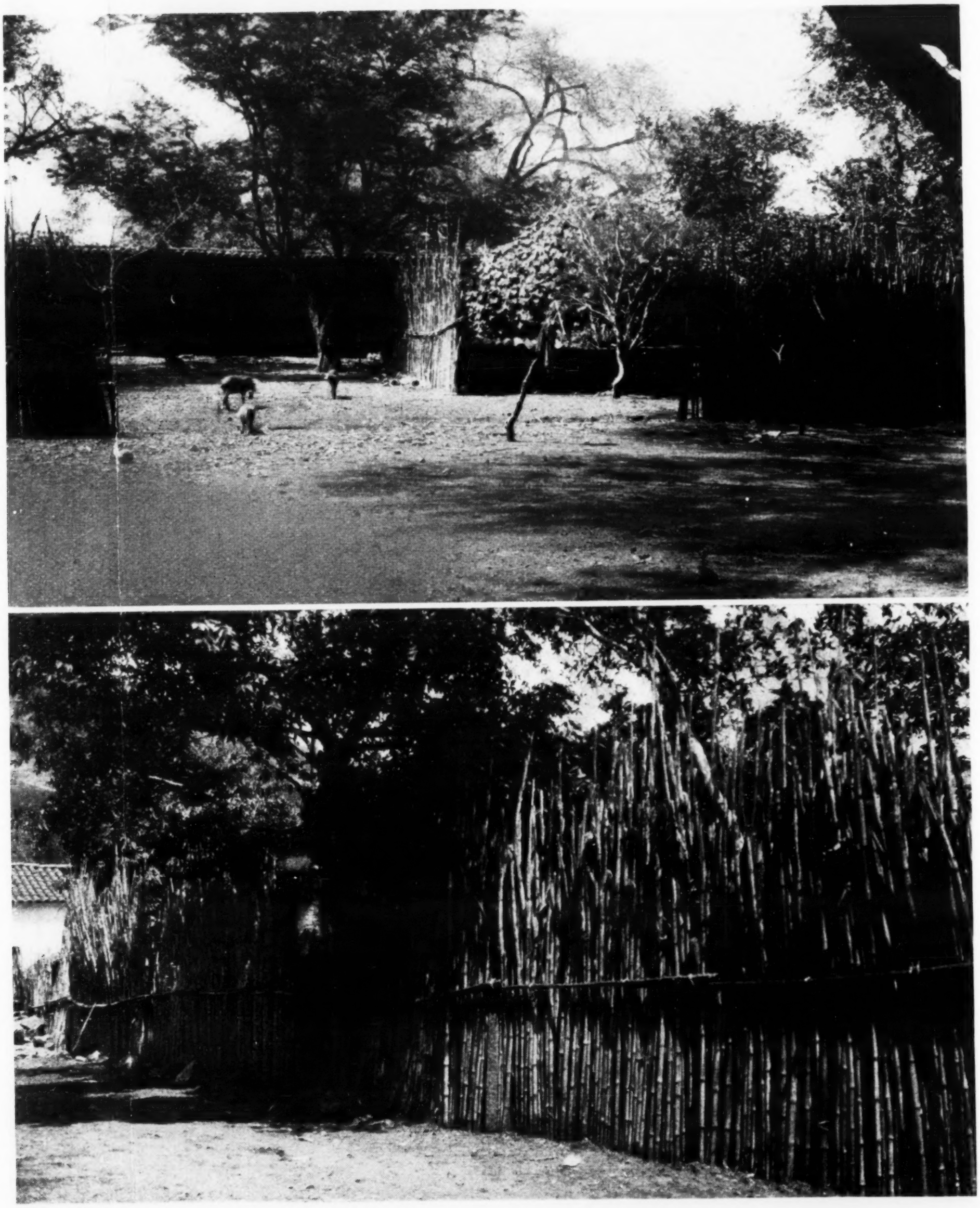
PART OF AN EAR OF JALA MAI

FIGURE 15. For comparison is shown an ear of Boone County Whi yield of Jala maize per acre is equalled or exceeded by the better varietie with a long growing-season, this giant maize might be of great value



F JALA MAIZE—NATURAL SIZE

e County White, a standard variety in the Middle West. Probably the better varieties grown in our Corn Belt, but for tropical countries, great value



FENCES MADE FROM CORN STALKS

FIGURE 16. Fences made from the stalks of Jala maize are strong enough to confine the ubiquitous Mexican pigs, several of which are shown in the upper photograph.

ROAD THROUGH FIELD OF JALA MAIZE

FIGURE 17. The ears are at such a height that they can just be reached comfortably from the saddle.

in the state of Nayarit on the west coast of Mexico, from which place we had obtained as early as 1907 a truly gigantic type of maize, the largest ears of which were twenty-two inches in length.

In the course of a recent journey through Mexco we have had the opportunity to visit the exact locality where this variety of maize is grown. The culture of this gigantic variety centers about the small town of Jala, sixty miles southeast of the city of Tepic and a few hours' journey by mule-back from the rail line now under construction by the Southern Pacific of Mexico.

The town of Jala is situated in a narrow valley at the foot of an extinct volcano. The very fertile soil is of a light porous nature common in volcanic regions, and the cultivation of maize has been continuous for a period of several centuries. The area devoted to maize, which is practically the only cultivated crop, does not exceed seven or eight hundred acres, the larger part being in a single block of about 640 acres. While this acreage is handled as a single tract, the field is in reality a community affair, with very small individual holdings. The general impression of the entire culture is one of unusual uniformity, with the ears just comfortably within reach from the saddle. The corn is planted in rows about three feet each way with an attempt to have two plants in a hill. It is planted in April and harvested in November. With a rainfall of forty to fifty inches, the water requirements of the plants spaced in this manner seem fairly well met. At the time of our visit in October, many of the leaves had been stripped or the plants topped, and while the ears were full size they were still far from mature.

Size of Plants

This maize is know locally simply as *mais de humido* and it seems fitting to give it the designation *Jala* from the town which it surrounds. The plants will average twenty feet in height and the ears about twenty inches in length and nine inches in circumference,

though it is possible to find individual specimens two feet in length and stalks over twenty feet high. In the number of seeds on an ear, the Jala variety does not differ materially from some of those grown in our Corn Belt. The number of seeds ranges from 700 to 1000 from which it naturally follows that the individual seeds are very much heavier than those of our mid-western dents. The mean weight of a single seed is over .6 grams, while on ears having but twelve rows the weight of a single seed often exceeds .8 grams. These weights may be compared with .3 grams for Boone, .33 grams for Laguna or 1.1 grams for Cuzco, the largest-seeded variety known. The leaves, tassels and diameter of the stalks are in proportion to the height. Indeed, the stalks furnish very suitable material for fencing in a region where other material for this purpose is scarce. While some of the varieties of maize from Guatemala have ears as long as those from Jala, they are smaller in circumference and the plants are less majestic in appearance.

That the size of this Jala type of maize is not merely the result of its favorable situation is shown by its behavior in this country. In the vicinity of Washington, D. C., it attains a size almost as great as that of its native habitat, though, of course, the season is far too short to mature seed. In Southern California, with a growing period of nine to ten months, this variety matures normally, though its great size does not seem so unusual under irrigation culture where gigantic plants are expected.

Neither is its size the result of a doubling in chromosome number, so often the case with other unusually large varieties of plants, as is shown by the studies of Dr. Longley, who finds that, as in most maize varieties, its haploid chromosome number is ten. We have made use of the divergence in size between this variety and some of the smaller pop-corns such as Tom Thumb to study the inheritance and particularly the correlation between size characters. Hybrids with smaller varieties are perfectly fertile and the possible range of height in maize is from less than one foot to over twenty feet.

While this type of maize is of little, if any, value to the corn growing region of the United States, it is of interest in demonstrating the great size that this species can attain, though in yield per acre *Jala* is doubtless equalled, if not exceeded, by our best varieties of the corn belt.

For tropical countries with a long growing season, there undoubtedly are possibilities inherent in this variety which would justify the careful attention of breeders.

ARGUMENTS ON RACE PREJUDICE

A Review

THE reactions that follow the bringing of different races together are among the phenomena that need to be studied from biological viewpoints and with scientific precautions. The race differences admittedly are of the same nature as differences of species or subspecies of plants and animals, but we do not know what such differences mean, in terms of race relations. Ecologists have studied the group of reactions of plants and animals, while the human contacts have been neglected. Whether we talk of "prejudice," "pride," or "feeling," the racial tensions apparently are increasing as the contacts are increased by modern facilities of communication. The work of Gobineau on the "Inequality of the Human Races" published in 1854, is recognized as one of the inciting causes of the recent World War.

In a field so thickly overgrown with superstition and controversy, the only hope of scientific comprehension or of constructive co-operation among the races is to get the underlying facts regarding the racial differences. Elaboration of more arguments from the abstract "principles" can only give us more variations of the same confusion that has prevailed in the past.

Argument rather than investigation is the method followed in the work on "Race Prejudice" by Jean Finot. The wrapper describes the book as "A thorough and admirable study of the races, their characteristics and mutual relations written from the point of view that the human race is one . . . and this work *Race Prejudice* is practically unanswerable as a vigorous argument for a new *entente* between all the nations of the world."*

The pragmatic reason for adopting the unitary new point is also stated quite frankly in the introduction:

"Currents of thought sway humanity like those of the atmosphere do a balloon poised in mid-air.

"On the reality or unreality of this principle, which dominates at the present hour the secret or avowed aspirations of the peoples, depends the whole of their future. Peace among peoples and the crown of such a peace —that is, the vast solidarity of mankind, the dream of the future—can in any case only triumph when founded on the conviction of the organic and mental equality of peoples and races."

Hence to establish this necessary conviction and sway the "currents of thought" in a desirable direction, the "practically unanswerable" argument was prepared, by a judicious selection and tempering of the "evidence." The book consists largely of a general review and discussion of anthropological and ethnological literature, treating of supposed racial characters and differences, with special emphasis upon the doubtful and conflicting nature of the evidence used by Gobineau and his followers to prove the inequality of the European races. Many of the inconsistencies of the Aryan myth are clearly recognized. The canvass of literature is extensive and many points in relation to the European races are well treated, though a book without an index is hardly to be considered as a work of reference.

The author's ideas of evolution would be described as ultra-Lamarckian. People of the most different races, if placed under the same conditions, are supposed to approximate rapidly. Slight changes of accommodation to conditions are taken for the same thing as

*"Race Prejudice," by Jean Finot, translated from the French by Florence Wade-Evans, published by Dutton & Company, New York, the introduction dated Paris, 1906.

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evolutionary changes and expected to continue. By resorting frequently to the *"milieu"* of environmental conditions, the racial differences are made to appear as of a very superficial and temporary nature.

Finot would cure war by showing that race differences are nothing to worry about, much less to fight about, and would encourage the races to go on living together and hybridizing, so that racial unity, if not a present fact, may become a reality in the future, and thus "prove" his argument. "The American nation proves by the unceasing progress which it has realized in so short a time, the indisputable advantages of cross-breeding practiced on an extensive scale."

The idea that races may be destroyed or degraded by mongrelizing is dismissed as mere pessimism or vanity. "In their inordinate pride, the whites have never been willing to admit that women of other races, and especially of so-called inferior ones, are able to give birth to children equal in value to pure white progeny." Instead of hybrid stocks deteriorating, a new law of racial amelioration is announced: "Whenever crossing takes place under normal conditions, inferior types become better without causing any degeneration whatever of the race or of the so-called superior classes." Finot does not understand that the later generations of a hybrid may be radically different from the first generation. He is not aware that a vigorous, resistant and productive conjugate generation, as of a cotton hybrid, may be followed by perjugate generations that show large proportions of defective, weak and sterile individuals, so that the hybrid population is far below the level of either of the parental stocks.

Finot's argument had the excellent object of counteracting the Gobineau argument that helped the Germans to start butchering their neighbors, but came too late to prevent the catastrophe. It is such blood-lust that Finot's gospel would quench, and he has a "formula" for producing peace among the races. Since there are no really pure, uniform races, and no definite boundary characters to set apart any of the races, he would have us believe that the races are all alike and equal, that they are merely "human varieties based on the differences caused by the changing influence of the *milieu.*" The evil spirits of race friction are to be exorcised completely by discarding the word "race" from our vocabulary, since race has no reality, but is "only a product of our mental faculties," like the idea of "disease" which is rejected by Christian Science. Thus the argument for racial unity and equality is brought to a conclusion by another assertion of the original thesis.

"The principle of human equality takes away the right of killing so-called inferior people, just as it destroys the right claimed by some of dominating others. If all peoples are equal, if their different appearances are only the results of changing circumstances, in virtue of what principle is it allowable to destroy their happiness and to compromise their right to independence?"

The author would declare the races equal, so that the principle of justice may be applied in all of the racial contacts, but overlooks the fact that the contacts are being increased largely for commercial and industrial reasons, not projected for mutual advantage, but in order that one race or class may exploit or live as a parasite upon another. The races of Europe have been in contact since prehistoric times, but many recent contacts have been made chiefly for purposes of exploitation. That such exploitation should be resisted is considered natural. The fact that parasitism tends to degeneration, and that race parasitism is race suicide, is another aspect of the problem that needs to be recognized and presented. The motives of gain have been so completely dominant in our commercial and industrial civilization that we have failed to recognize the anti-human reactions of our commercial system. When the biological consciousness has developed further and the folly of parasitism is appreciated, the relations of the races may be placed on a different footing.

Obviously the practical solution of the race problems does not lie in the direction of independence and segregation of each local group that may at any time develop tensions with its neighbors and may wish to separate. Such tensions and cleavages are by no means confined to racial groups though often confused with the race problems. It is plain that the general application of such a "principle" could only carry the world rapidly backward to the barbarism of tribal chaos from which the present national organizations emerged so painfully after the Dark Ages. Under the Roman system many races functioned together for a long period, but sank into barbarism as the central organization broke down.

Some of the national organizations in Europe were condemned as too centralized, artificial and oppressive, and were discarded in the recent war period, but the need of racial understanding and co-operation is not diminished by the political separation of the groups.

In view of the failure of the European races to bridge their differences and reach harmonious adjustments through intermarriages, after centuries of intimate contacts, it is the less to be expected that any such bridging and blending will close the racial gaps in other parts of the world. Mixing of races has been tried on all the racial frontiers, but seems not to lessen "the unending difficulty of wholesome human relations between human races of different and unequal development." The mixed offspring do not form a bond of increasing good will between the parent groups, but raise a barrier of hostility. A recent writer on the Netherlands Indies has well described the typical social reaction of the racial hybrids.

"In the main the Eurasians oppose the further development and education of the Natives. They do so because they fear them. They realize that they are so completely outnumbered that the rising power of the Malays will be acquired at their expense. Consequently, they are more Dutch than the Dutch and resist any movement that may lessen the power of Holland in the islands. Their position in this matter probably is well founded, for it is apparent that much more actual feeling exists between the Eurasians and the Malays than between either the Dutch and the Natives or the Dutch and the Eurasians."

Of course, it may always be said that mixed populations do not come from the best stocks of the parent races, and that the experiment of race amalgamation has not been fairly tried. This is a futile argument, since people who are sufficiently enlightened to be responsible parents will not wish their children to have the difficult status of the racial hybrids. Half-castes of European races usually see little reason why they should love their white fathers. Thus more "prejudice" is generated, so that the race tensions may be increased rather than diminished by racial interbreeding. The eugenic improvement of the separate races would be a better project for humanitarians than trying to get the races mongrelized.

Finot reflects no appreciation of eugenic interest in maintaining or improving his own race or the others. His zeal for "the lifting up of the so-called inferior races" seems to be inspired more by the desire to assert "universal principles" than from a constructive interest in human nature, white, black or yellow. Such were the French doctrinaires of *Les Amis des Noirs* in the eighteenth century, whom historians have charged with instigating the revolt in San Domingo. Finot has nothing to say of San Domingo, though he has special chapters on the progress of the negroes in the United States and in the British West Indies. If it is recognized that the French racial policy of the eighteenth century led to disaster, similar errors in the twentieth century should be avoided.

Saying that the races are equal does not make them alike, and it is folly to ignore the differences that exist,

or to suppose that the race problems are all. Even among members of the same race slight divergent interests or beliefs have often led to the collective madness of civil wars. But the recognition of natural inequalities or differences affords no reason or excuse for imposing any artificial inequalities of social or political status. Such discriminations are not only unjust and futile, but always injurious to the race that assumes the relation of a parasite. Certainly there is no "principle" to justify any exploitation or oppression of one race by another. Not only slavery, but any other forced exploitation of backward races, as of the defective or dependent people of civilized countries, is open to the same objection that is felt when prison labor is brought into competition with the normal industry of law-abiding people.

Civilization is not the exclusive possession or accomplishment of any one race, but an accumulation of the experiences of many races, through thousands of years. Our European civilization was not an indigenous development but came from the Orient through the Greeks and Romans, and new elements are still being borrowed from every part of the world. The accumulation of experience is going forward more rapidly than ever before, with more contacts made possible by modern facilities of communication. The scientific study of the race characters is a new and more difficult field of investigation, as yet hardly entered. Certainly there is as yet no basis for determining the future prospects of possibilities of civilization of different races in advance of the necessary opportunities of constructive contacts.

O. F. Cook.

An Encyclopedia of Sex

Handwoerterbuch der Sexualwissenschaft, herausgegeben von Max Marcuse. Pp. 481, price $5.50. A. Marcus & E. Webers Verlag, Bonn, 1923.

This substantial encyclopedia, with its nearly 500 closely printed, large pages of two columns each, covers a wide ground; and, as the editor remarks in his introduction, its subject matter effects every human being. Dr. Marcuse has associated with himself, in the undertaking, several dozen competent collaborators. Most of the articles concerned more directly with genetics or eugenics are from Agnes Bluhm or H. W. Siemens. A long article on psychoanalysis, and several others, are by Sigmund Freud himself. As befits an encyclopedia, the tone of all the articles is conservative, and in the case of the many disputed questions both sides are given a hearing.

Some biologists have doubted the desirability or necessity of establishing "sexual science" as a discipline by itself. Nevertheless its field is pretty well defined. In the past the preoccupation of most students of this subject with its abnormal phases has alienated most biologists. There is some evidence that this lack of balance is being corrected and that biology of sex is gradually becoming more and more settled on a normal basis. As such, it is an indispensable part of all practical eugenics; and those interested in it will find this comprehensive encyclopedia almost indispensable. A valuable feature is the full citation of literature at the end of each of the principal articles.

P. P.

MOTTLING OF SOYBEANS*

C. M. Woodworth†
University of Illinois

and Leon J. Cole
University of Wisconsin

OF RECENT years the appearance of mottling in yellow and green seeded varieties of soybeans has attracted a good deal of attention on the part of soybean growers. Seeds with black hilums are black mottled, and seeds with brown or colorless hilums are brown mottled. The mottling consists of patches, blotches, or bands of black or brown pigment, irregular in outline and extent, superimposed on a ground color of yellow or green. In some rare cases, the mottling consists of patches of both black and brown pigments on yellow or green ground color.

Mottling is an undesirable character because it arouses the suspicion that the mottled variety is not pure. It also interferes with the correct identification of varieties. For these reasons it is particularly objectionable from the standpoint of seed certification.

The mottling here spoken of should not be confused with such distinct patterns as are shown by some varieties of soybeans. The Black Eyebrow, for example, has a brown ground color with a saddle of black covering the greater portion of either side of the bean. In the Meyer variety, the ground color is also brown, but the black pigment is usually in concentric rings around the hilum. There is also the pattern referred to as "eye," in which black or brown pigment forms a ring around the hilum as in black-eyed kidney beans. Nagai and Saito[1]‡ call this a "patched" pattern, which they assume is due to partial inhibition of pigment caused by the genetic factor *K*. These authors also describe a black mottling or pattern in soybeans due to the genetic factor *M* which develops the black pigment in this pattern. Such characteristic patterns as those above described are quite faithfully reproduced in succeeding generations, and appear to be scarcely if at all affected by differences in soil or climatic conditions. Hence, these patterns can be adequately explained on a genetic basis.

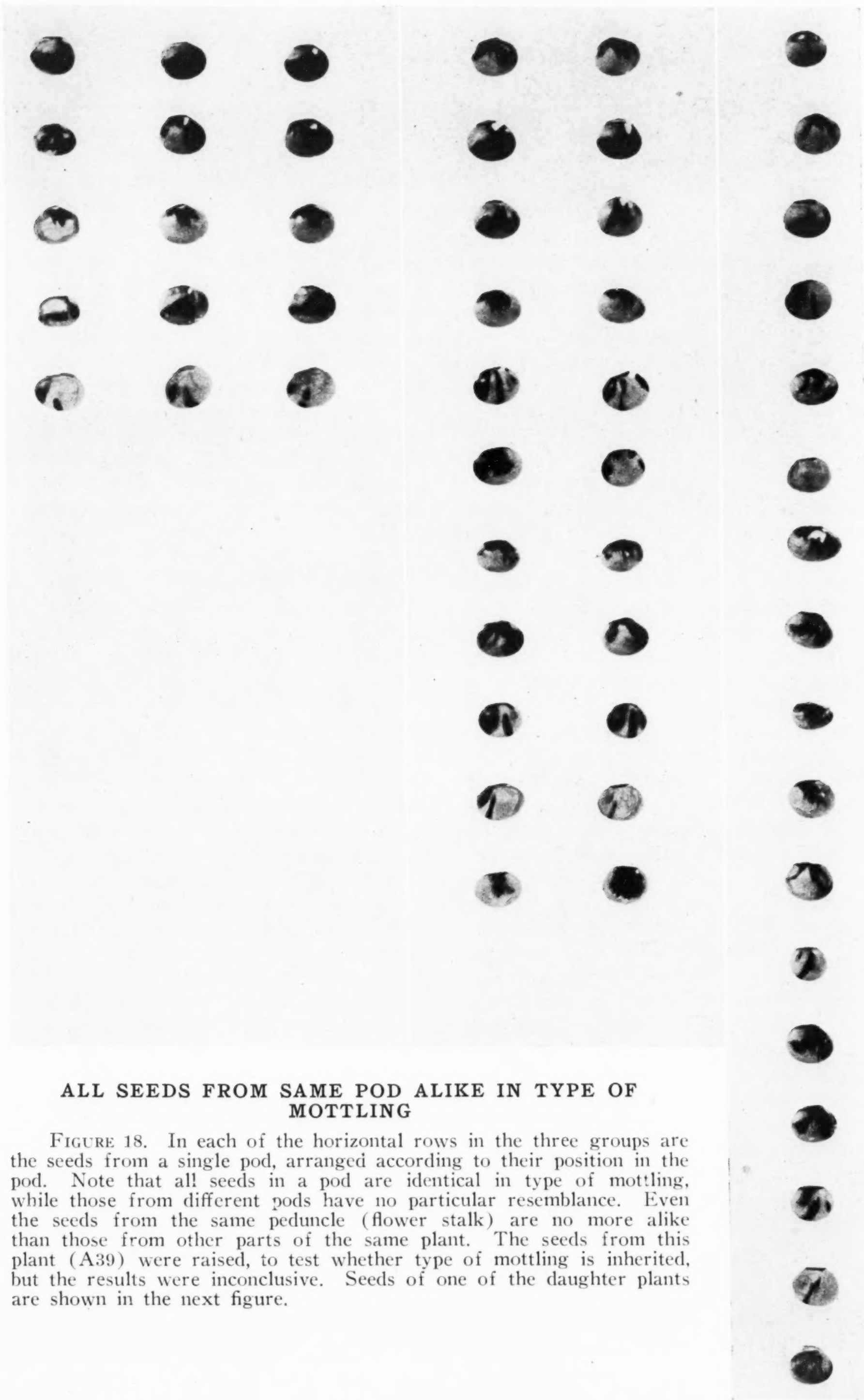
Variation in Mottling

In another respect, too, mottling appears to belong to an entirely different category from the varietal patterns described above. A striking feature of mottling is the variation in extent and expression on beans of the same variety. In a bulk sample of seed all gradations are found from those in which the ground color is almost or quite obscured by the black or brown pigment to those which show absolutely no mottling whatever. The same can be said, in many cases, of seeds produced by a single plant. Even in plants where the extent of variation is not so marked it is seldom that one can find two mottled seeds that are exactly alike. On the other hand, a bulk sample of Black Eyebrow shows the characteristic pattern in every seed, though, of course, there are slight variations in the proportions of black to brown on individual beans. Moreover, the beans produced by a single plant of this variety are practically identical in the expression of the pattern. The same

*Paper from the Department of Genetics, Wisconsin Agricultural Experiment Station, *No.* 47. Published with the approval of the Director of the Station.

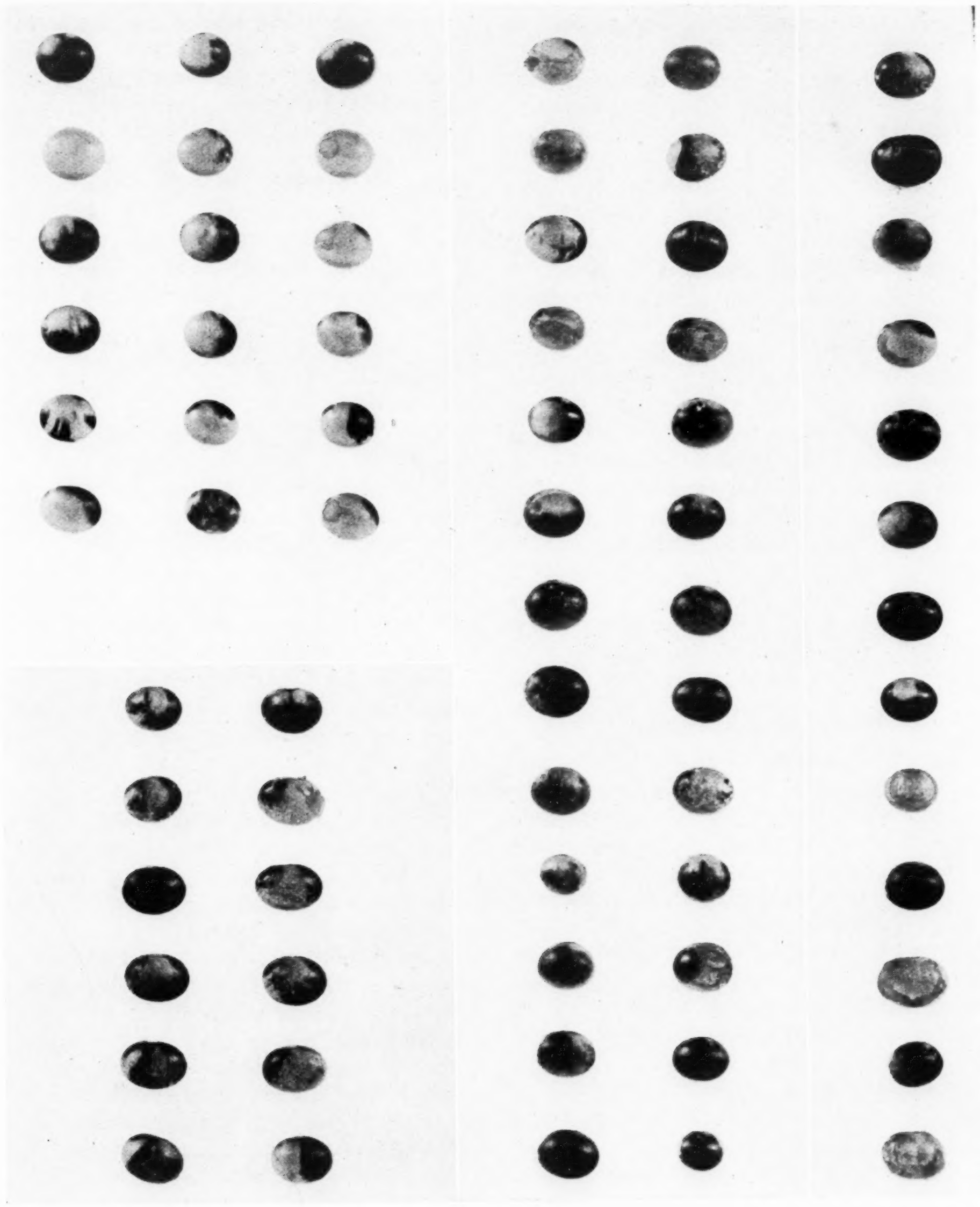
†Formerly Assistant in the Department of Genetics, University of Wisconsin.

‡For numbered references see Literature Cited at end of article.



ALL SEEDS FROM SAME POD ALIKE IN TYPE OF MOTTLING

FIGURE 18. In each of the horizontal rows in the three groups are the seeds from a single pod, arranged according to their position in the pod. Note that all seeds in a pod are identical in type of mottling, while those from different pods have no particular resemblance. Even the seeds from the same peduncle (flower stalk) are no more alike than those from other parts of the same plant. The seeds from this plant (A39) were raised, to test whether type of mottling is inherited, but the results were inconclusive. Seeds of one of the daughter plants are shown in the next figure.



SEED FROM PROGENY OF PLANT A-39

FIGURE 19. The seeds are arranged in the same way as those of the parent plant, except that some of those from the two-seeded pods are transposed to the bottom of the three-seeded column to conserve space. In this plant the seeds from the same pod are no more alike in mottling than those from different pods. At present there is no satisfactory explanation of the occurrence of this type of mottling, which does not appear to obey any of the known laws of inheritance, and yet is not altogether controlled by the environment.

can be said of other distinct patterns which have come to be recognized as characteristic of this or that variety.

Our experience with mottling in soybeans dates from 1917. Progenies produced by self-fertilization, from two varieties which had been hybridized in 1916, showed considerable mottling. One of the varieties had a yellow seed-coat mottled with brown; the other a green seed-coat mottled with black. The hilum color of the former was typically yellow but in the mottled beans it was wholly or partly brown according as the brown pigment covered the hilum wholly or partly. If the hilum was not reached by the brown pigment at all, it was yellow as in typical non-mottled beans. The hilum in the green-seeded variety was black in both mottled and non-mottled beans. In every other way the beans and plants were typical of their respective varieties. The mottling had not been observed before this time in these or any other varieties included in our studies.

Breeding Experiments

In 1919 several pure-line plants of the green-seeded, black-mottled variety were studied pod by pod. As the seeds were removed from each pod they were arranged according to the number of seeds per pod, and then according to their position in the pod; that is, they were oriented the same way, the germ end of the bean pointing always in the same direction. Figure 18 is a photograph of the seeds of a single plant (A39) arranged in this way.

Several interesting points were brought out by this study. In any particular two-seeded or three-seeded pod, the type of mottling was practically identical. The expression "as nearly alike as two peas in a pod" applies particularly to this situation. However, it could not be said that there was any similarity between the types of mottling exhibited by seeds from different pods. No two pods were alike, unless, of course, they contained seeds showing no mottling whatever. Finally, there appeared to be no relation between the types of mottling shown by seeds in pods borne on the same peduncle. If the identity in mottling found on seeds in the same pod could be attributed to similarity of conditions of development, it might be expected that pods borne on the same peduncle would be more alike than those borne on different peduncles. This, however, was not the case in these plants. Plant A39 is only one of about 155 plants grown that season which showed the similarity of mottling to a greater or less extent in seeds from the same pod. This plant was chosen as one of the most striking examples. This similarity was not noticed in other progenies of that year.

The next year, 1920, all the seeds of plant A39 (Figure 18) were planted in such a way that each resultant plant could be traced to a particular seed as well as to a particular pod. This plan admitted of determining whether a particular type of mottling was inherited. Also, it admitted of comparing the progenies of seeds coming from the same pod on the parent plant, and having, therefore, identical types of mottling.

The results were inconclusive. The progenies were studied as were the parents—pod by pod. There seemed to be no tendency for particular types of mottling to be inherited. Progenies of non-mottled beans were no different from progenies of mottled beans so far as the extent of mottling was concerned. There was no relation, apparently, between progenies from seeds coming from the same pod on the parent plant. And finally there was not the same identity in type of mottling shown by seeds borne in the same pod; in fact, there was scarcely any more similarity than was shown by seeds in different pods (see Figure 19).

Causes of Mottling

There are at present no satisfactory explanations for the occurrence of mottling. In another paper[2] (footnote, page 516) the following statement was made concerning the appearance of this

character in pure lines of the two varieties mentioned above. In this statement the word pattern has the same meaning that the word mottling has in this paper.

> The cause of development of the pattern in pure-lines of self-colored beans is not at present known. It is a phenomenon of wide occurrence, appearing in a number of yellow and green varieties in many sections where soy-beans are grown. Seeds with such a pattern show no segregation on being tested and hence are not the result of hybridization. There are indications that the causal factors are, in part, physiological rather than genetic in nature, for the following reasons: (1) the wide variation in the extent of the pattern (from self-yellow or self-green to self-brown or self-black) on seeds from the same plant; and (2) the striking similarity in some material in the pattern shown by seeds in the same pod, and the dissimilarity of seeds in different pods though borne by the same plant. The study of the factors involved in the development of the pattern is of great practical importance from the standpoint of the uniformity of soy-bean varieties. It is hoped that investigations now in progress will throw some light on this problem.

Since this statement was written, we have made very little progress in determining the cause or causes of mottling. It still appears that we are correct in maintaining that this character is not the result of hybridization. Several considerations incline us toward this view. The mottling is a seed-coat character. In a cross involving seed-coat characters, we expect that all the seeds borne by the hybrid will be alike in appearance. If, for example, the coat color of one parent is dominant, all the seeds produced by the first hybrid generation (F_1) plants will show this color. Similarly, if the result of the cross is patterned seeds, as when a yellow-seeded and a brown-seeded variety are crossed, all the seeds produced by the F_1 plants will show practically the same type of pattern. True hybrids for seed color, therefore, are different from mottled plants. Furthermore, when a yellow-seeded and a brown-seeded variety are grown side by side for the first time, and the seeds of the former, at harvest, show brown mottling, this result cannot be attributed to a cross because (1) the chances for natural crossing are extremely small,[3] and (2) if a cross did occur, the hybrid seed-coat character would not appear until the next plant generation is grown and seeds are produced. Finally, as pointed out above, we have observed mottling appearing in pure lines of soybeans which up to that time had bred true for all characters studied. Had the mottling been the result of a cross with another variety we should expect that both parent types would reappear among the progeny in later generations. On the contrary, these pure lines continued to breed true for all varietal characters except the mottling.

It also appears that we were correct, in 1921, in ascribing the mottling partly to physiological factors and for the reasons then given. Obviously all the seeds of a plant do not have the same conditions for growth and development, the same nutrition, the same temperature, the same moisture relationships. Possibly this fact may account for the wide variation found in the type and extent of mottling on seeds from the same plant. Conversely, the practical identity of conditions obtaining in the same pod may account for the marked similarity in type of mottling observed on seeds borne in the same pod. However, the latter statement loses some of its weight when it is remembered (1) that seeds borne in pods on the same peduncle were no more alike in type of mottling than those produced on different branches, and (2) that the identity in type of mottling did not reappear in the multi-seeded pods of the progeny grown in a different season.

We consider the individual plant as a unit genetically. All seeds produced by a single soybean plant are alike in their genetic constitution except with respect to endosperm characters, such as cotyledon color, segregation in which may and does occur on individual plants. Since mottling is a seed coat character, and not a cotyledon character, it is obvious that there should be no differences among the seeds pro-

duced by a single plant with regard to the transmission of the mottled character even though these seeds vary greatly themselves in the extent and type of mottling manifested. This statement is confirmed by the experimental results.

If all the seed-coats produced by a single plant could be spread out and fitted together so as to show the extent and type of mottling of that plant as a whole, we should be enabled to make more accurate comparisons among individual plants. The mottling would appear not unlike the spotting characteristic of certain breeds of cattle, as the Holstein-Friesian. No two animals show exactly the same type of spotting. A great range of variation exists resulting in animals that are almost self-black and those that are almost self-white, with all gradations between these extremes. The situation in single soybean plants with respect to mottling is quite similar. Furthermore, non-mottled beans are no more different genetically from mottled beans on the same plant than are the white spots on a Holstein factorially different from the black spots. It is possible that the extent and expression of mottling on different plants are controlled by genetic factors, as seems to be true for spotting in animals. Further speculation is useless, however, until more experimental evidence is available on this seemingly complex character in soybeans. It might be thought that the situation here is somewhat similar to the non-hereditary mutational patches of color in corn[4] and assumed to be due to somatic (sporophytic) mutation; but if such were the case the effect might occasionally be expected to extend to adjacent pods. As was noted, there seemed to be no such similarity on pods in the same peduncle.

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INHERITANCE OF CANCER

Genetic Indications Correlated with the Transplantation of Cancerous Tissue*

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ANY specialized pursuit is apt to become extremely technical. Especially when the time comes to give the data to other people, one feels the loss of common language for expression. The tendency to be misunderstood is prone to arise, not so much when the investigation is confined to a single science or subject, but when, as in the present case, there is an attempt made to co-ordinate the findings of two distinct sciences, genetics and pathology. I find myself at a loss, therefore, to express my ideas clearly either to geneticists or pathologists. When I address a group of geneticists, I am very liable to be misunderstood by using terms that are wholly acceptable to pathologists. On the other hand, as in the present case, my terms, very evident to a group of geneticists, might be misconstrued and myself misunderstood.

In this paper, giving some of the results of my recent investigations on the transplantation of cancerous tissues, I shall not bore you with detailed accounts of experiments and statistics that arise in laboratory routine. Rather shall I discuss a philosophical background, that a proper orientation to the subject in hand shall be evident.

It has been aptly stated that cancer is the "most important problem in the entire domain of pathology." Any work, then, however theoretical or fragmentary, ought to be, at least, worthy of your consideration, as unquestionably it is.

Nature of Tumors

Perhaps, it may be well to start the discussion from the known. A question that is frequently asked is, "What is a tumor?" Of course, we all know what a tumor is. Thanks to our modern clinical and pathological investigations, we are now able to classify cancerous growths rather carefully. A tumor is, according to a leading authority, "a more or less circumscribed collection of cells arising wholly independently of the rest of the body, in general growing progressively, and serving no useful purpose in the organism." Add to this, the fact that the growth is uncontrolled by any physiological check that the organism is able to exert upon it and we have the neoplasm defined.

But let us ask the same question again, what is a tumor? Meaning what is the ultimate nature of this uncontrolled growth mass, what is, to be explicit, the *cause* of this monstrosity. The answer is not so evident. In fact, it has been stated by a leading pathologist, that we are no nearer to the solution of the cancer problem (that is, the problem of causation) than Hippocrates was. True, we have our theories—a thousand or more of them—from the idea that cancer comes from eating tomatoes, to the conception that a cancerous growth comes from the delayed development of a mythical included twin of the host. The entire gamut has been run: all of them interesting; some of them fascinating by their mere audacity; others, very suggestive and

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fruitful. No one theory is entirely acceptable. It is probable, however, that the cancer problem might be correlated with the biological phenomena of growth and differentiation. A cancer mass, however, departs in several characteristic features from normal biological matter. In the first place, a cancerous growth has uncontrolled growth capacity, whereas in all normal biological forms, growth is determined or controlled. Normal growth obeys certain fundamental laws, some of which have already been determined. For example, by studying the rate of growth of several chick embryos, we are able to determine fairly accurately, the rate of others belonging to a new experiment. On the other hand, we may study the rate of growth of any number of neoplastic tissues, classifying the neoplasms even by their microscopic anatomy, and yet be unable to foretell the present or future fate of a new growth in the same class. Again, all normal growth leads to differentiation — during embryonic growth, to further development; after adult form has been reached, to progressive differentiation of the cell contents, unless a new equilibrium be reached by a process of reproduction or otherwise. Not so, in the case of neoplasms. The cancer cell possesses immortality, it remains exactly as it was at its initial appearance. Certain neoplasms, particularly the Flexner-Jobling rat sarcoma, have not changed in their appearance or physiological activity after twenty years of transplantations. The cancer cell is the only organism possessed of perpetual growth vigor and at the same time which lacks the power of differentiation—here we have growth without differentiation.

Now growth and differentiation are both biological phenomena and therefore the cancer cell should be of paramount importance not only to the medical. man but also to the biologist.

Methods of Attack

There are apparent two main procedures to approach the so-called cancer problem. The first method may be called the direct, that is, to study the cancer cell itself. To study its gross and microscopic structure, to compare and contrast its properties with that of normal cells, to determine its origin, life history, and so forth; to test the physical and chemical agencies that may have an effect upon its life; to determine its characteristics and peculiarities — and then to visualize the process or processes involved in the formation of such a growth. The second method is to me, however, the more correct procedure; this is to study the individual or host that gave rise to the spontaneous growth in the first place. The question, why does the individual give rise to a neoplasm?, is placed before the other question of the origin of the cancerous growth itself. If we knew the individual completely, then we ought to be able to understand the changes within the organism that caused the production of the new growth. There are in turn two possible methods of attack under this second idea that the individual should be the center of our scientific researches and not the cancer growth itself. All individuals are produced, in the last analysis, by the actions and reactions of two and only two sets of forces, heredity and environment.

Our two procedures, therefore, that attempt to determine the fundamental attributes and characteristics of the individual host must consider either the one or the other of these two forces. The first and most obvious method is to study the environmental influences. Does health, as dependent upon proper nutrition, uniform exercise, suitable and sanitary accommodations, etc., have any bearing upon the fact that certain individuals give rise to neoplastic growths? Are there particular groups of substances, such as narcotics, coal tar, phosphorus, that act as stimulants for the onset of malignant changes within the organism? Is there a necessary correlation between an injury and a cancerous growth? These and many other problems are involved for the

study of the individual from the standpoint of the environmentalist.

Some twenty years ago a reaction occurred among a particular group of biologists. To be specific, among a group sometimes referred to as the experimental evolutionists. After several years of painstaking research, doubt was felt as to the real progress being accomplished in their particular field, and the conclusion was reached that perhaps we didn't know as much about an individual as we thought we had in the time of Charles Darwin. Evolution could not be controlled by careful selection, as was then held. The nature of the organism itself escaped us—it was more than what we had figured upon. From this doubt, there arose a new attempt to unravel the hidden mysteries of the individual, to determine the ultimate nature of the organism, to trace out its very origin from the germ—the science of genetics was born. Genetics concerns itself, as has been stated, with the ultimate nature of an individual, with the origin of the characteristics from the egg and sperm, and lastly, with the transmission of the characteristics from one generation to the next.

To some biologists, the study of inheritance is the most important part of the science of genetics. But to me, this particular phase of genetics is only of secondary importance. I am primarily interested in the individual—not in the transmission of the individual characteristics to the next generation. Genetics, although an infant in years, or I should say a young man, since it reached its twenty-first birthday last spring, does show us something of the fundamental nature of individuals that we are interested in.

The Genetic Mechanism

Let us consider, then, a few of the salient points that have been recently discovered from the study of genetics. You may recall the early stages of mammallian development. Every individual starts out in life as a single fertilized unit (called the zygote). This single bit of living protoplasm soon divides again to form four cells, then eight and so on for a few more divisions, then the regularity of the cell division is lost, the embryo loses its original radial symmetry, becomes elongated and finally differentiates into several directions until the adult body is built up. It was formerly assumed that the original zygote was homogeneous—that is, that the entire cell was a unit in itself, and that the entire mass of the zygote gave rise by the process of cell division, growth and differentiation of certain cells to the entire adult body. We have changed our conceptions concerning the nature of the zygote. We have, by long and tedious experiments, been able to determine that the zygote is not homogeneous, but that there is an apparently localization of germinal areas in the zygote (some of which are already determined in the unfertilized egg) and further that these localized areas give rise to particular parts or areas of the adult body. In some forms, at least, the polarity, symmetry and general form of the adult are predetermined by localized areas in the cytoplasm of the unfertilized egg. The specific and detailed characteristics, and I may add from my own work, some of the physiological functions of the individual are determined by localized areas within the nucleus of the zygote—and since both the male and female parents contribute identical masses of nuclear material, these later characteristics of the individual are determined, to a great extent at least, by both parents. The work on the identification of the location of these specific determiners within the nucleus of the zygote is truly remarkable. In one form of animal, the common fruit fly, we have been able to map out, as it were, the internal constitution of this nuclear material.

Every cell, when ready to divide to form two daughter cells, undergoes a very elaborate process known as mitosis. The process is briefly as follows: The so-called chromatin material of the nucleus, which in the resting condition

of the cell is scattered in the form of loose patches throughout the nucleus, gradually resolves itself into a definite number of filamentous bodies, known as chromosomes. Every species of plant and animal has a definite number of these so-called chromosomes. Each chromosome then splits longitudinally and becomes placed upon a spindle. The chromosomes halve, then separate and go to the opposite ends of the cell. A furrow grows in between the two newly formed chromosome groups, which in turn spin out into a resting nucleus with the chromatin material in the original condition. Thus two cells are formed from a single pre-existing cell.

The chromosomes are the structures within the nucleus that contain the specific determiners of the adult characteristics previously referred to. These adult determiners are lined up in a linear order along the chromosomes—some determiners being in one chromosome, other determiners being in another chromosome, and so on.

A simple experiment will present the crucial test of the conception that the morphological characteristics of the adult are determined by single units located on the chromosomes in the nucleus of the zygote that gave rise by development to the individual. By mating together a pure brown-eyed individual to a blue-eyed individual, the children belonging to the so-called F_1 (first hybrid) generation will all have brown eyes like the one parent. Then by mating together two individuals that belong to the F_1 generation (all of which have brown eyes), another hybrid generation known as the F_2 is obtained. In this generation, the second filial generation, we obtain two classes of individuals; some of the individuals have brown eyes and some have blue eyes and these individuals are always present in the very definite ratio of three browns to one blue. This result can only be explained by the assumption that eye pigmentation in the last analysis is determined by single units from the germ plasm, that are known now to be carried on the chromosomes. Time forbids my further discussion of this phenomenon. I hope that you accept this contention as definitely established to the satisfaction of geneticists.

The zygote is, therefore, a very complex structure. We have, however, been able to determine some of its mysteries. And since the adult individual is only the product of the development of the zygote, plus certain environmental influences, we are able to approach the age-old problem of the fundamental nature of the living organism. Let me emphasize the point, therefore, that the specific morphological characteristics of the adult individual are determined or produced by certain specific units introduced into the individual with the formation of the zygote.

Transplantation Experiments

Let us now examine some of my own recent experiments upon the transplantation of cancerous tissue and show the relationship of this work upon the genetic implications of the fundamental nature of the individual.

My first experiment* dealt with the innoculation of a malignant tissue (adeno-carcinoma) subcutaneously into a series of hybrid mice of known relationship. Two original stocks of mice were employed. Every individual of the first stock (dBr) grew the transplant progressively; and every individual of the second stock (albino) proved to be resistant to the same tissue. By crossing these two distinct races of mice, a hybrid generation, known as the first filial generation, was produced, all the individuals of which reacted to the transplant as did the first original stock, that is, all the individuals grew the transplant progressively. By mating two individuals of this hybrid first filial generation together, a second filial generation was obtained that contained two classes of individuals as far as their physiological

*The sequence of experiments has been changed in this paper for purposes of presentation.

reactions to the same transplanted tissue was concerned. Three individuals out of every four obtained were like the original susceptible race and grew the tumor progressively; one out of every four individuals was negative like the second original albino non-susceptible race: a typical 3:1 ratio was obtained. This experiment demonstrates, therefore, that susceptibility to a transplantable tumor is dependent upon the same ultimate mechanism that the inheritance of eye pigmentation apparently is dependent. A particular individual grows a transplanted tumor because there is present in its ultimate make-up at least a single germinal determiner for a special physiological function that was obtained from the zygote that gave rise to the individual.

My second experiment dealt with the comparative study of two histologically identical tumors that had, in spite of their identical morphology, given different physiological reactions when inoculated simultaneously into a series of mice of known ancestry. By the use of controlled genetic crosses between two carefully selected stocks of mice, I was able to determine that for an individual to grow the first tumor, there must be the simultaneous presence of at least two separate determiners derived from the zygote; and that for the continued growth of the second transplantable tumor there must be within the individual host three independent genetic determiners. The two determiners discovered are probably common to both neoplasms. The second transplantable tumor, however, necessitates the presence of a distinct third unit not functioning, as far as is discernible, for the successful growth of the first malignant tissue.

The significance of this last discovery can, however, only be determined by several other very crucial experiments now under way. Whether you accept the conclusion that these data merely indicate that when two histologically identical tumors possess different physiological reactions, these different reactions are produced by undetermined differences within the tumor mass not discernible to the histologist, or whether you believe, as I do, that this experiment demonstrates the existence of genetic differences within the tumor cell, which accounts for its particular reaction with the individuals harboring the transplant, is immaterial with our present knowledge. I am firmly convinced that this method outlined above, will not only supply the means of studying such biological phenomena as tissue specificity, and genetic physiology, but also will lead, somehow or other, into the demonstration of the ultimate nature of the tumor mass.

The last experiment I desire to outline this evening deals with the analysis of growth of the transplantable tumor. Continuing the work on the transplantation of malignant tissue into several hybrid generations, I have been able to determine the fact that the reason why a given individual grows the transplanted tissue at a certain rate is determined by the presence of these same genetic determiners derived from the zygote that gave rise to the individual. It is apparent, therefore, that not only the fact of progressive growth of the transplanted malignant tissue, but also the fact of a definite growth rate of the same mass is determined, in the last analysis, by genetic factors which obey definite known laws of inheritance. The mechanism of growth determination of the transplanted neoplastic tissue has therefore been demonstrated.

Of my other experiments, time forbids a further discussion.

Relation of Transplantable and Spontaneous Tumors

In conclusion, I want to answer a question that is sure to be asked. The question may be stated as follows: What bearing does the study of the transplantable tumor have upon the more important problem of the spontaneous growth? Is it not generally accepted that the two phenomena are entirely distinct and should be kept distinct? In answer to the second question, I may state that it is the

common opinion of the modern pathologist that the transplantable tumor study will never lead anywhere. Since this present paper attempts to present a philosophical background for my own work, I venture to express a doubt as to the present status of the work on transplantation.

There is no one who would venture, with our present knowledge, to formulate any conclusion concerning the spontaneous tumor from the study of the transplantable tumor. My experimental work has only been with transplantation and I accept unreservedly the present limitations. At the same time, I cannot believe that the phenomenon of the transplantable tumor has nothing in common with the spontaneous tumor. Until I have definite proof to the contrary, I consider myself justified in believing that the characteristics of the transplantable tumor cell are also, to some extent, at least, common to the characteristics of the spontaneous cell. One argument advanced by certain pathologists, that the transplantable tumor is wholly distinct from the spontaneous tumor, is the apparent fact that regression of the transplantable tumor is a fairly common phenomenon, whereas regression and absorption is a rare occurrence for the spontaneous growth. Permit me to add one other bit of data from my most recent experiment. I have been able, by genetic analysis, to determine that when a transplanted tumor mass regresses, that it is not entirely the fault of the tumor cell but rather the fault of the host—regression of transplantable tumors runs in genetic families and is, therefore, strictly inherited, as is also the fact of progressive growth and the rate of progressive growth. Give a transplantable tumor the proper soil, determined by the genetic constitution of the individual, and the transplantable tumor mass will also never regress.

Traits and Races

HUMAN TRAITS AND THEIR SOCIAL SIGNIFICANCE, by IRWIN EDMAN, Instructor in Philosophy, Columbia University. Pp. xii+466. Price, $3.75. Houghton Mifflin & Co., Boston.

The book is an attempt to give a bird's-eye view of the processes of human nature, from man's simple inborn impulses and needs to their complete fulfillment in the activities of religion, art, science and morals.

To the readers of the *Journal of Heredity* the chapter on Individual Differences is of peculiar interest. The author names sex, race, ancestry, and environment as the causes of individual differences. He declares that individual mental differences have comparatively nothing to do with sex. He further maintains that there is little mental superiority of one race over another. "Races as races seem to be equally gifted." Mr. Edman recognizes the fact of heredity, both mental and physical, and it would therefore seem as logical to claim physical similarity for all races as to deny mental differences. He considers the really important influence in determining individuality to be "immediate ancestry," or family, and we feel impelled to ask, "It not the family the final representative of the race? and is not family influence, then, in reality race influence?" Environment, Mr. Edman says, can merely touch heredity, no more. An individual, especially among the cultured classes, is practically independent of environment. The net result in this field, he says, is the discovery that men are most diverse and unequal in interest and capacity. The ideal of equality comes to be equality of opportunity, natural inequality remaining incontestible and unconquerable.

The book contains a vast amount of material of interest to the student of human progress and especially to the psychologist. A. C. C.